

REMARKS

Claims 1-124 are pending. In the Office Action dated November 6, 2006, the Examiner rejected claims 1-124 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 6,477,614 to Leddige *et al.* in view of U.S. Patent No. 5,546,591 to Wurzburg *et al.* and further in view of U.S. Patent Application Publication 2005-0177755 to Fung.

Disclosed examples of the invention include memory modules having memory hubs connected to a plurality of memory devices. The memory hub includes an activity sensor that monitors the amount of activity of the memory module, and a power controller that is coupled to the activity sensor. The power controller directs the memory module to a reduced power state when the module is not being used at a desired level. See Abstract. Insofar as the activity sensing and resulting power management occurs in the memory module itself, the disclosed power-saving techniques can be applied selectively. This selective application is in contrast with conventional systems that are implemented across an entire system for example, placing a system in a standby mode, or that are implemented in a controller for the power-consuming devices. See ¶ 33. For example, using the disclosed system, a first memory module having a first range of addresses that are frequently accessed can remain operating at full power and capability while a second memory module having a second range of addresses that are less frequently accessed can operate at reduced power and capability.

U.S. Patent Number 6,477,614 to Leddige *et al.* has been cited for disclosing a computer system having a processor, an input device, an output device, a memory controller, and a plurality of memory modules coupled to the memory controller and having memory devices mounted on an insulative substrate. Applicants acknowledge that computer systems having these components are well known, and, in fact, used in virtually all personal computer systems. However, as the Examiner acknowledges, the Leddige *et al.* patent fail to disclose an activity sensing device to monitor the activity of the memory module, and a module power controller operable to direct the memory module to a reduced power state responsive to the output of an activity sensing device.

U.S. Patent Number 5,546,591 to Wurzburg *et al.* has been cited for disclosing an activity sensing device monitoring activity of a memory module in processing memory

commands, and an module power controller directing the memory module to a reduce power state responsive to the activity sensing devices. Applicants disagree with this characterization of the teachings in the Wurzburg *et al.* patent for several reasons. First, the Wurzburg *et al.* patent does not disclose any power management system for memory devices. Instead, Wurzburg *et al.* teach power management units for peripheral devices, which are enumerated as keyboards, display screens, printers, modems, and disk drives. See col. 1, lines 23-25. While the teachings of Wurzburg *et al.* would admittedly be applicable to peripheral devices other than those specifically listed in lines 23-25, memory devices are not considered “peripheral devices.” If the Examiner believes they are, applicants respectfully request that some reference be cited that evidence memory devices being considered “peripheral devices.” Second, even if memory devices could be considered “peripheral devices,” the patent to Wurzburg *et al.* would suggest only an activity monitor 38 and power control be provided in a controller 36 for the peripheral devices 26. Therefore, applying the teachings of Wurzburg *et al.* to computer systems having a memory controller coupled to a plurality of memory modules, Wurzburg *et al.* would teach controlling power at the controller level rather than the memory module level. For this reason, the power to all of the memory modules connected to the same controller would be controlled in the same manner. The power consumed by a frequently accessed memory module would therefore not be controlled differently from the power consumed by a less frequently accessed memory module, as in applicants’ disclosed system. For the Wurzburg *et al.* patent to suggest individually controlling the power consumed by several memory modules connected to the same controller, it would have been necessary for the Wurzburg *et al.* patent to suggest individually controlling the power consumed by several peripheral devices connected to the same controller. More specifically, it would have been necessary for the Wurzburg *et al.* patent to teach the local power management unit 38 in the peripheral device itself 26 rather than in the peripheral controller 36. But the Wurzburg *et al.* patent does not contain such teaching.

The Office Action admits that the Wurzburg *et al.* patent fails to disclose activity monitoring at a local level, but contends that “such limitation is not demonstrated in the claims.” Applicants disagree that the claims are not limited to activity monitoring and power control at the local level. Although the claims may not contain the term “monitoring at the local level,” monitoring and controlling power at the local level is the effect of placing the activity monitor

and power controller in the memory module rather than in a memory controller that is connected to a plurality of memory modules. By placing the activity monitor and power controller in the memory module, the power consumed by each of a plurality of memory modules can be individually monitored and controlled, *i.e.*, controlled locally at the module level.

U.S. Patent Publication No. 2005/0177755 to Fung has been cited for disclosing the use of a temperature sensor to sense the level of activity of a circuit, as recited in some of the dependent claims. However, the Office Action does not content that the Fung patent contains any teachings that are missing from the teachings of the Wurzburg *et al.* patent or the Leddige *et al.* patent as applied to the independent claims.

Turning, now, to the claims, independent claim 1 specifies a memory module comprising an activity sensing device, and a module power controller that is responsive to the output of the activity sensing device for directing the memory module to a reduced power state responsive to the output of the activity sensing device indicating a relatively low level of activity of the memory module. As explained above, none of the cited references, taken alone or in combination, suggest a memory module as recited in claim 1.

Claim 26 is directed to a memory hub disposed on a memory module in which the memory hub has an activity sensing device and a module power controller. As explained above, the cited references do not disclose or fairly suggest a memory module having an activity sensing device and a module power controller, and they certainly do not suggest a memory module having a memory hub containing an activity sensing device and a module power controller.

Claim 48 is directed to a memory system having a memory controller connected to a plurality of memory modules of the type to which claim 1 is directed. Claim 48 is therefore patentable for at least the same reason that claim 1 is patentable. For claim 48 to be suggested by the Wurzburg *et al.* patent in combination with the other cited references, it would have been necessary for the Wurzburg *et al.* patent to teach several peripheral devices 26 connected to the same peripheral controller 36, and an activity sensing device and power controller in each of the peripheral devices 26. For this reasons, as well as the reasons explained above, the cited references fail to suggest the subject matter of claim 48.

Claim 74 is directed to a computer system containing the memory system of claim 48, and is therefore patentable for at least the same reasons that claim 48 is patentable.

Claim 100 is directed to a method of controlling power used in a plurality of memory modules associated with a system. The claim specifies individually measuring activity in response to memory commands from the system in at least some of the memory modules, *i.e.*, local monitoring of activity in memory modules. The claim further specifies determining when each of the memory modules is inactive based on lack of activity in response to nonrefresh memory commands from the system measured in the respective memory modules, *i.e.*, again, local activity monitoring. Finally, the claim specifies directing at least one of the memory modules into a reduced power state when it is determined that activity of the memory module is not of a desired level. As explained above, none of the cited references, including the Wurzburg *et al.* patent, suggest monitoring activity in each of a plurality of memory modules and then using the monitored activity to individually control the power consumed by the memory modules.

All of the claims remaining in the application should now be allowed. Favorable consideration and a timely Notice of Allowance are earnestly solicited.

Respectfully submitted,

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Enclosures:

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Fee Transmittal Sheet (+copy)

Supp. IDS

Form PTO-1449 with (9) cited references

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